Homing in *Urosalpinx cinerea* in Response to Prey Effluent and Tidal Periodicity

BY

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(1 Text figure)

INTRODUCTION

At the University of Rhode Island's Narragansett Bay Campus, two parallel breakwaters extend at right angles from a sandy beach out into the bay, forming a basin for small boats. They are made of jumbled angular blocks of undressed stone up to 1 m^3, are heavily populated with *Balanus balanoides* (Linnaeus, 1758) and, from June to September with oyster drills, *Urosalpinx cinerea* (Say, 1822), feeding apparently exclusively on the barnacles. The floor of the basin is flat, its sediment a coarse sand. Oyster drills are never found on the sandy shoreline between the breakwaters, and during the summer the two snail populations are discrete. The situation raised the following questions: 1) if snails from the two populations were deposited at an intermediate point, would they tend to home to the breakwaters from which they were taken? and 2) how quickly would they return?

MATERIAL and METHODS

On July 8, 1975, 1625 oyster drills were taken from the inner side of the southern breakwater, which is 35 m long, and 1928 from the inner side of the northern breakwater, 41 m long. They were spray painted with fast drying enamels: the southern snails yellow, the northern snails white; and within 5 hours of capture all were returned to the middle of the boat basin where at Mean Low Water the water is 1.6 m deep and the breakwaters are 20 m apart at water level. The assistance of Brian Melzian in this day's task is gratefully acknowledged.

For the next 75 days the breakwaters were searched daily at or near low tide, allocating time and effort in approximate proportion to the length of each breakwater. Marked snails were collected and taken to a distant area for release.

RESULTS and DISCUSSION

The results are summarized in Table 1. The snails' tendency to return to the breakwater of their origin was quantified in a normal approximation to a test of proportions, which yielded the highly significant value of 5.235 ($t_{0.001, \infty} = 3.291$). The probability of no homing response, *i. e.* random dispersal, is therefore less than one in a thousand. What directional clue they used is not known.

Table 1

Number of oyster drills marked and recaptured

	North Breakwater	South Breakwater	Total
marked	1928	1625	3553
recaptured on breakwater of origin	350	234	584
recaptured on opposite breakwater	165	254	419
total recaptured	515	488	1003

Strong as this statistical result is, the homing response was complicated by an attraction to the north breakwater that affected not only the snails originating there (68% of recaptures) but also those from the south breakwater (52% of recaptures). This may be explained as follows.

Balanus balanoides exerts a powerful olfactory distant attraction for this oyster drill population (PRATT, 1974). There are more barnacles on the north breakwater, which is not only longer than the south breakwater but also is thickly populated with barnacles for more of its length. In addition, the tide along this shore ebbs southward with visible velocity but on the flood no northward current is perceptible. The presumed greater volume of barnacle effluent and rate of flow from the north may combine to explain why slightly more snails from the south breakwater were recaptured on the north breakwater than on the south.

The temporal pattern of the snails' return to the breakwaters can be seen in Figure 1, which shows the numbers of marked snails recaptured daily (all results combined). Thirteen days elapsed before the first returning snails accomplished the 10m trek along the bottom from the release point. Their return occurred in waves, of which at least 3 are clearly shown and a fourth is suggested. These waves came during periods of neap tides as can be seen in the correspondence of daily returns with the daily means of the predicted semidiurnal low tides. The lower edge of the band of barnacles is at about 5cm above Mean Low Water. During spring tides, these prey of the snails are exposed to air for varying periods twice a day. Only during neap tides are they continuously immersed and infusing the water with their chemical attractant. This may account for the biweekly pulsed return of the oyster drills to the breakwaters.

The oyster drill populations of the breakwaters, numbering several thousands in July and August, declined sharply in September. Water temperatures ranged between 20 and 23° C during July and August except for readings of 24 - 26° C for August 2 - 5; the September

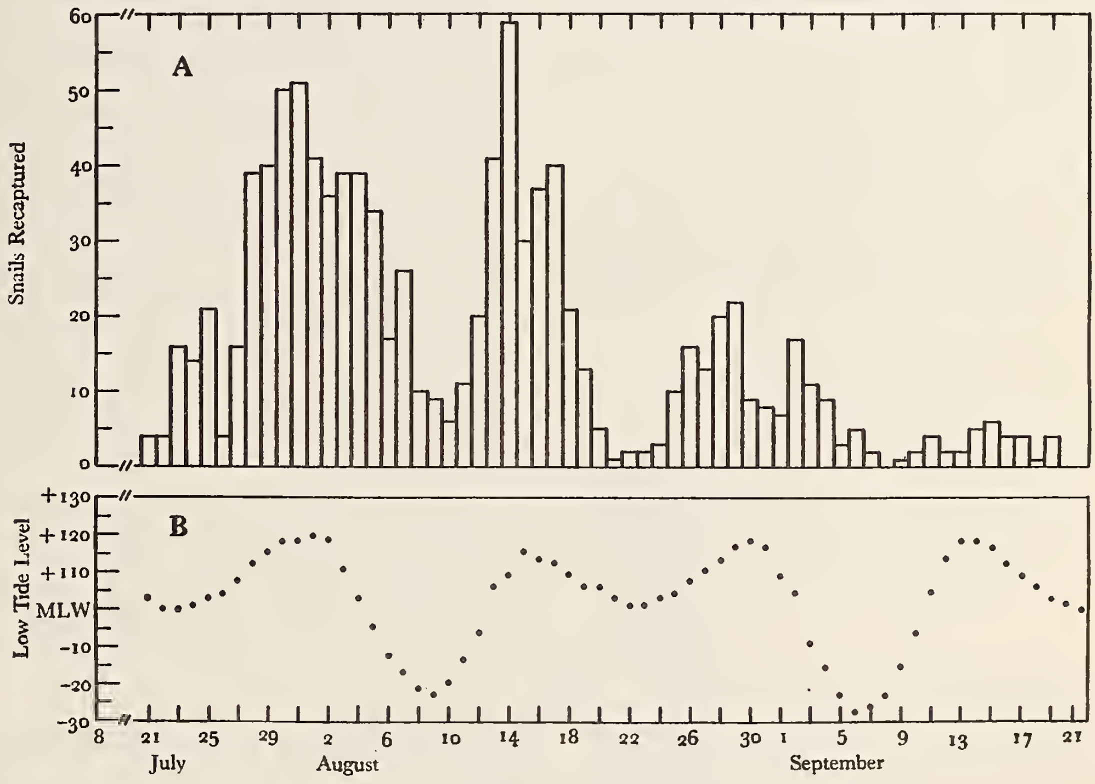

Figure 1

A. Daily recaptures of marked snails on the breakwaters
B. Daily averages of low tide levels (cm)

temperatures declined from 19.9 to 18.0° C. Oyster drills normally disappear from the breakwaters in October, presumably to overwinter on the bottom of the boat basin (Carriker, 1954, 1955). The return of marked snails to the breakwaters during the September neap tides was counter to, and largely obscured by, the seasonal downward mass movement.

Movements on the order of a meter and an hour or two, which return the animal to its approximate starting point, are known in a number of prosobranch and pulmonate snails, their precision and adaptive advantage varying with the species' way of life. Individual periwinkles, *Littorina littorea* (Linnaeus, 1758), make short feeding excursions during a tidal cycle in a U-shaped course that maintains their vertical position on the shoreline (Newell, 1958). Limpets, whose homing has been studied for nearly 150 years, home with great precision to their individual scars on the rock surface where they can withstand the molar action of waves (MacGinitie & MacGinitie, 1949). In spite of considerable experimentation (Cook, 1969; Cook *et al.*, 1969) their navigational systems remain obscure. Funke (1968) lists 34 species of marine gastropods (29 of them limpets) and 10 species of land snails but none from fresh water that are known to have homing abilities.

The homing tendency of *Urosalpinx cinerea* is on larger spatial and temporal scales than those described for other snails. Quantities and concentrations of prey adequate for the summer's foraging of a population of oyster drills are highly localized. The drill's habit of overwintering at some distance from its food supply, coupled with its limited powers of locomotion, would be a serious drawback in a random springtime search for a summer feeding ground. These disadvantages are overcome by any tendency to migrate in an appropriate direction. Upward movement from the deeper overwintering grounds will provide enough direction in some situations but in others will misguide the snail. Here the chances for success will be improved if the geotactic response is supplemented by some other clew that has previously rewarded the snail. The oyster drills' decided preference for the home breakwater suggests such an additional directional impulse.

Literature Cited

Carriker, Melbourne Romaine
1954. Seasonal vertical movements of oyster drills (*Urosalpinx cinerea*). Proc. natn. Shellfish Assoc. 45: 190 - 198
1955. Critical review of the biology and control of the oyster drills *Urosalpinx* and *Eupleura*. Spec. Scient. Reprt. U. S. Fish & Wildlife Serv. (Fish.) 148: 1 - 150

Cook, A., O. S. Bamford, J. D. B. Freeman & D. J. Teideman
1969. A study of the homing habit of the limpet. Anim. Behav. 17 (2): 330 - 339; 9 figs.; 1 table

Cook, Susan Blackford
1969. Experiments on homing in the limpet *Siphonaria normalis*. Anim. Behav. 17 (4): 679 - 682; 1 fig.

Funke, Werner
1968. Heimfindevermögen und Ortstreue bei *Patella* L. (Gastropoda, Prosobranchia). Oecologia 2: 19 - 142; 25 figs.; 9 tables

MacGinitie, George Eber & Nettie MacGinitie
1949. Natural history of marine animals. McGraw-Hill Book Co., New York, N. Y. xii+473 pp.; 286 text figs.

Pratt, David Mariotti
1974. Attraction to prey and stimulus to attack in the predatory gastropod *Urosalpinx cinerea*. Mar. Biol. 27 (1): 37 - 45; 2 figs. 3 tables